Section: B

Question: 2

(i) 3

Given Data:- Columb's constant $= K = 9\times10^{9}\ Nm^2/C^2$

Magnitude of charge $= 3\,\mu C$

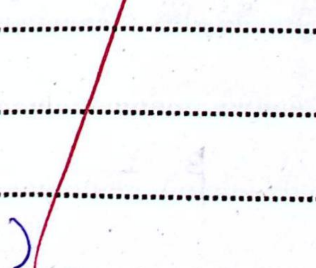
$= 3\times10^{-6}\ C$.

Distance $= r = 30cm = 30\times10^{-2}\ m$

Required Data:

Electric Field $= E_p = ?$

As we know that:



$$E_p = \frac{kq}{r^2}$$

Putting the given values:

$$E = \frac{(9\times10^{9})(3\times10^{-6})}{\underbrace{30\times30\times10^{-4}}_{10}}$$

$$\Rightarrow E = \frac{9 \times 10^4}{30} N/C$$

$$\Rightarrow E = 3 \times 10^3 N/C$$

(xi)

$$\beta = \frac{\alpha}{1-\alpha}$$

Proof:-

As we know that:

$$\beta = \frac{I_c}{I_b} \rightarrow ①$$

Also;

$$I_E = I_b + I_c$$

$$\Rightarrow I_E - I_c = I_b \rightarrow ②$$

Using eq② in eq①: we get;

$$\beta = \frac{I_c}{I_E - I_c}$$

Dividing numerator and denominator by "I_E":-

$$\beta = \frac{I_C}{I_E} \div \frac{I_E}{I_E} - \frac{I_C}{I_E}$$

$$\boxed{\beta = \frac{\alpha}{1-\alpha}} \rightarrow (A) \quad :- \quad \frac{I_C}{I_E} = \alpha.$$

4

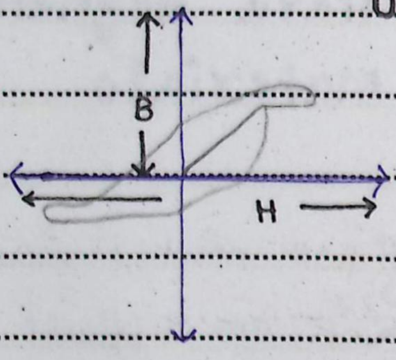
Thus equation (A) is the required proof.

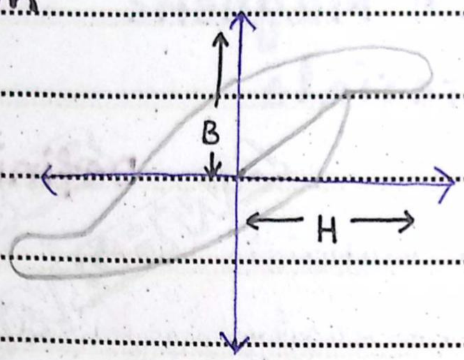
ix

Soft Magnetic Materials	Hard Magnetic Materials
Definition	
• Those materials which can be easily magnetized and demagnetized is called soft materials.	• Those materials which are difficult to be magnetized and demagnetized is called hard materials.
Co-ericivity	
• They have **low** co-ericivity and retentivity.	• They have **high** co-ericivity and retentivity.
Uses	
• They are used for making	• They are used

the cores of Transformers.	for making permanent magnets.
Hysterisis Loop	
• They have narrow hysterisis loop.	• They have fat hysterisis loop.
Example	
• Soft Iron is the example of soft materials.	• Steel is the example of hard materials.

Diagram





ii

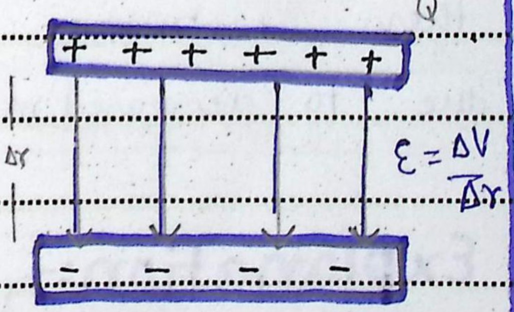
Proof:-

- Consider two oppositely charged parraled plates having separation "Δr". Let the plates are large compared to distance between them. So that, the field is uniform between the plates. Let a charge is moved from one plate to another plate then work done on the charge is given by:

$$W = F \cdot d \longrightarrow ①$$

As; $F = QE \rightarrow ②$ and $d = \Delta r$.

Using eq ② in eq ① we get:



$$W = (QE)(\Delta r)\cos 180^\circ$$

$$\Rightarrow \quad W = -(QE)\Delta r$$

Dividing both sides by "Q":

$$\frac{W}{Q} = -(E)(\Delta r)$$

$$\Rightarrow \quad \Delta V = -(E)(\Delta r) \quad \Rightarrow \quad E = \frac{-\Delta V}{\Delta r}$$

Hence;

$$E = -\frac{\Delta V}{\Delta r} \longrightarrow (A)$$

Equation (A) is the required proof.
The negative sign shows that the field is in the direction of decreasing electric potential.

xii

Statement:-

• If an electron and proton have same de-Broglie wavelengths then electron will have greater speed due to decreased mass.

Explanation:-

• The waves associated with particle is called matter wave.
According to de-Broglie, its wavelength is given by:-

$$\lambda = \frac{h}{mv}$$

$$\Rightarrow \quad v = \frac{h}{m\lambda}$$

As; $\frac{h}{\lambda}$ = constant:

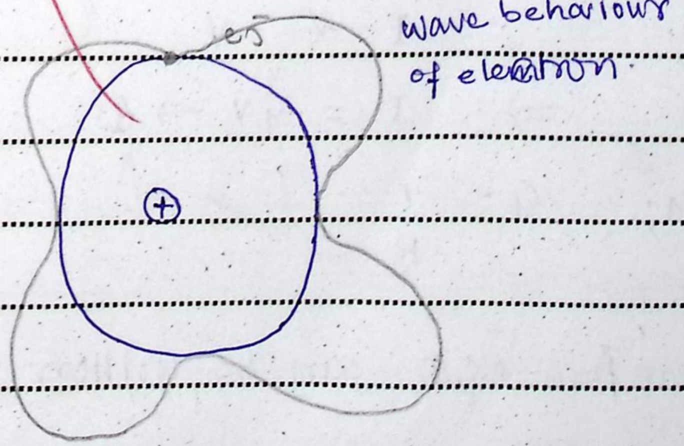
$$\Rightarrow \quad v = \frac{\text{constant}}{m}$$

$$\Rightarrow \quad v \propto \frac{1}{m}$$

Above relation shows that a particle having low mass will have greater speed and the particle having high mass will have low speed.

As; $(m)_{electron} < (m)_{proton}$

Therefore; the speed of electron will be greater than speed of proton due to its low mass.



V

Ohm's Law:-

a):- proposed By:-

This law was proposed by George Simon Ohm in 1826.
It gives relationship between current and voltage at constant temperature, resistance and other external condition.

b): Statement:

According to this law:-
" The current flowing in a conductor is linearly related to potential difference across the ends of conductor.

c): Mathematically:

$$I \propto V$$

$$\Rightarrow \quad I = GV \rightarrow (1)$$

As; $G = \frac{1}{R}$

Therefore eq.(1) can be written as:

$$I = \frac{V}{R} \longrightarrow (2)$$

$$V = IR \rightarrow (3)$$

Equation (1), (2) and (3) represents ohm law;

4

Ohmic Substances:-

Those substances which obey ohm law i-e in which current and voltage are linearly related is called ohmic substances.

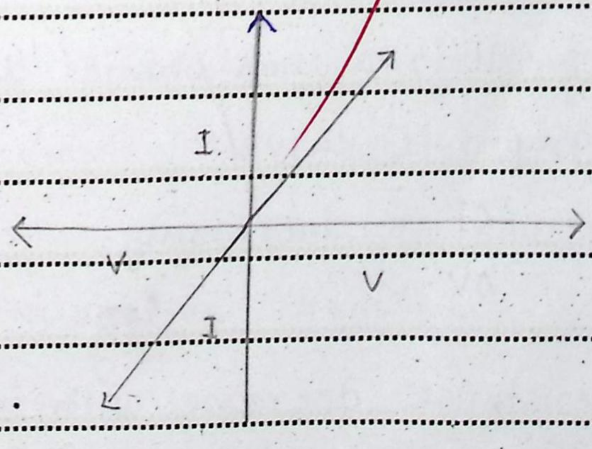
→ Slope $= \frac{\Delta I}{\Delta V}$ = constant

⇒ The resistance of ohmic substances is independent of voltage.

Example:

- Metals are the example of ohmic substances.

Graph:



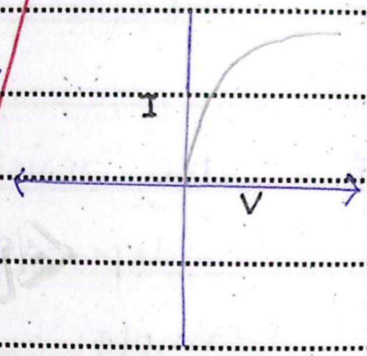
Non-Ohmic devices:

- Those substances which do not obey ohm law is called non-ohmic substances.

Example:-

a):- Fillament Bulb:-

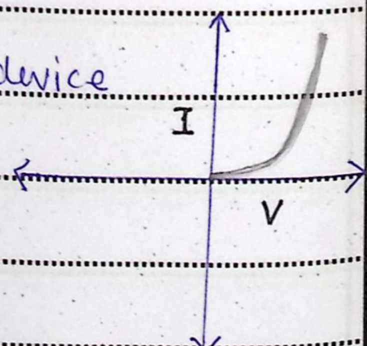
- It is a non-ohmic device.
- Its graph is a curve
- Slope = $\frac{\Delta I}{\Delta V}$ is decreasing



- Its resistance increase with increase in temperature i-e resistance depends upon voltage.

b):- Thermistor:-

- It is a non-ohmic device
- Its graph is curve.
- Slope = $\frac{\Delta I}{\Delta V}$ = increasing.



- Its resistance decrease with increase in temperature.

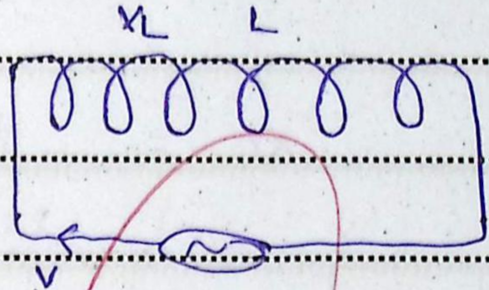
viii

Inductive Reactance:

The opposition offered by an inductor to flow of current is called inductive reactance.

OR:

The $\frac{V_{rms}}{I_{rms}}$ for inductor is called inductive reactance.



Mathematically:

The inductive reactance of an inductor is given by:

$$X_L = 2\pi f L$$

As; $2\pi L$ = constant. so;

$$X_L \propto f$$

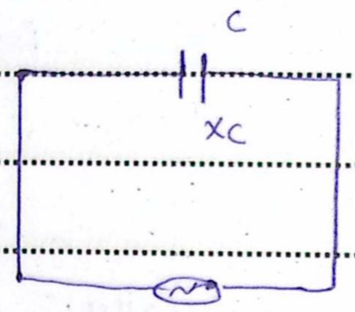
Above relation shows that increasing the

Capacitive Reactance:

The opposition offered by a capacitor to the flow of current is called capacitive reactance.

Mathematically:-

capacitive reactance of a capacitor is given by:



$$X_C = \frac{1}{2\pi f C}$$

As; $2\pi C$ is constant.

so;

$$X_C \propto \frac{1}{f}$$

Hence; increasing the frequency will decrease capacitive reactance and decreasing the frequency will increase the capacitive reactance.

so; Doubling the frequency of capacitor will halve the capacitive reactance.

iv

1 Volt:

The electric potential difference is said to be 1 volt if 1J work is done by electric field on one columb charge.

$$1V = \frac{1J}{C}$$

4

1 Electron Volt:

. The energy gained or lost by an electron is said to be 1eV if it is accelarated acron potential difference of 1volt.

$$1eV = (\text{elementary charge})(\text{volt})$$

$$1eV = (1.6 \times 10^{-19})\,J \longrightarrow \text{Ⓐ}$$

Equation shows the relationship b/w the ev and volt.

Difference:-

1):- Volt is the unit of potential difference. Electron volt is the unit of energy.

2):- Volt is the unit of "V" which is

the property of field. However, electron volt is the property of matter.

3):- volt is a larger unit while ev is a smaller unit.

vii

Statement:

Current carrying coil behaves as a bar magnet because it effectively has north and south poles.

Explanation:

→ consider a coil carrying current "i" then the field around the coil is same as that of bar magnet.

" the magnetic field is directed externally from north to south pole while internally from south to north pole".

" The magnetic field lines form close loop just like bar magnet.

" The direction of ~~curr~~ magnetic field due to current in bar magnet is found by RHR (Right hand Rule). just like bar magnet.

xiii

Pair Production:-

The phenomenon of splitting of a photon to produce an electron and positron pair is called pair production.

or

The conversion of energy to mass is called pair production.

4

As in pair production mass is converted into energy therefore it is also called materialization of matter.

There are three conservation laws in pair production.

a): Law of conservation of charge:

• The electron and positron are produced to conserve charge. If electron and positron are produced in pairs then ~~energy~~ charge will be conserved and the process will occur.

As;

(charge on photon) = (charge on electron) + charge on positron

$$\Rightarrow \quad 0e = (-e) + (+e)$$

$$0e = -e + e$$

$$\Rightarrow \quad \boxed{0e = 0e}$$

Law of conservation of momentum:

• Momentum is only conserved in the presence of nucleus and is not conserved in the absence of nucleus. So, pair production does not occurs in vacuum.

Law of conservation of energy:

• To conserve energy, the photon must have minimum energy = 1.02 MeV.

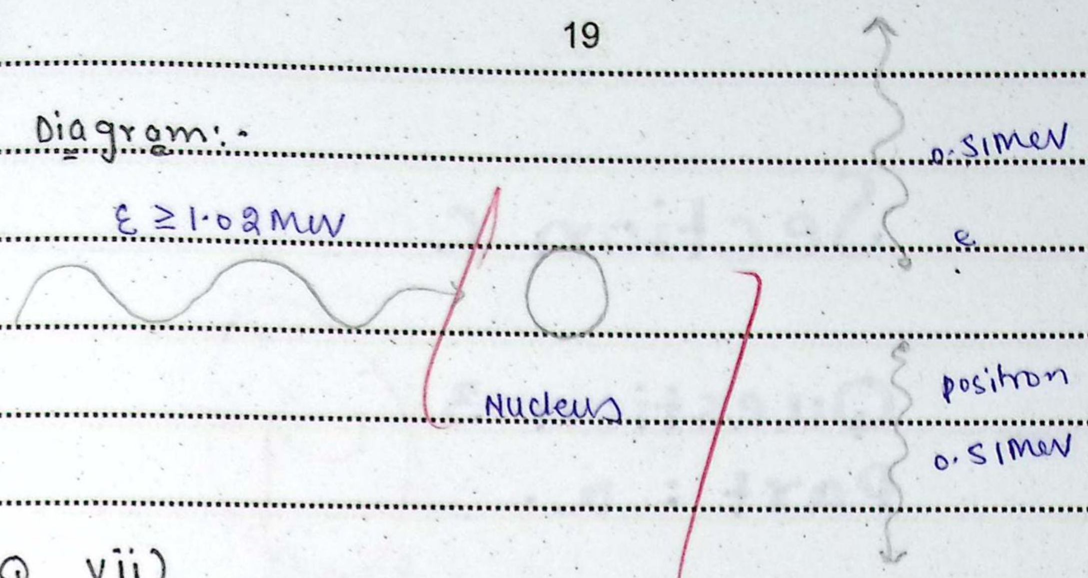
→ If the energy is greater then it will appear in form of kinetic energy.

$$1.02\,\text{MeV} = m_oc^2 + m_oc^2$$

$$1.02\,\text{MeV} = 0.51\,\text{MeV} + 0.51\,\text{MeV}$$

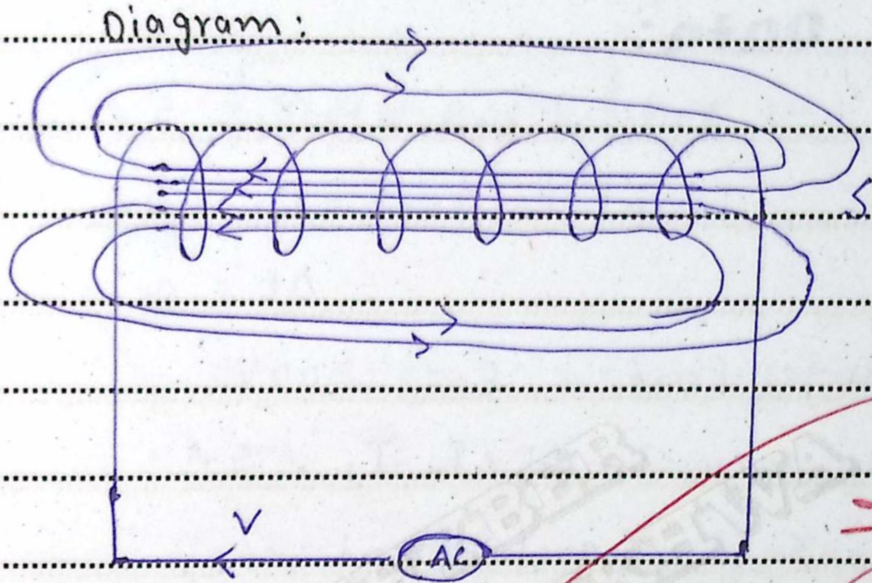
$$\Rightarrow \quad 1.02\,\text{MeV} = 1.02\,\text{MeV}.$$

Diagram:-

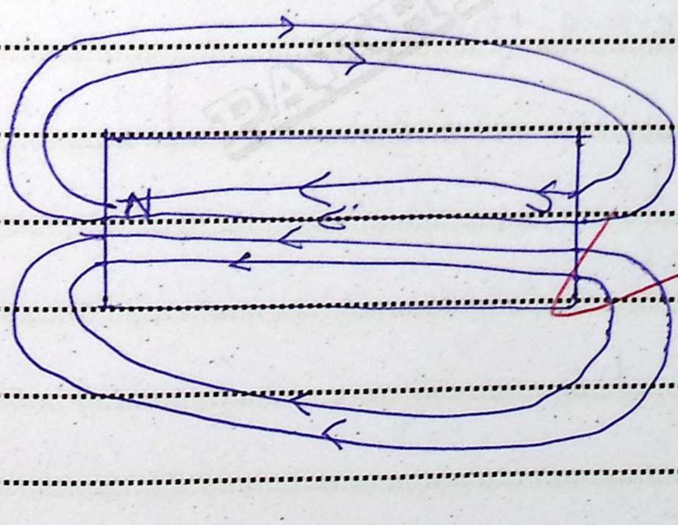


(Q vii)

Diagram:



Extra



Bar magnet

A

Section C

Question 3
Part : a.

9

Given Data:

Initial current $= I_1 = 5\,A$

Final current $= I_2 = 0\,A$

Time $= \Delta t = 0.1$

Average Emf $= \mathcal{E} = 200V.$

Change in current $= \Delta I = I_2 - I_1 = 5A.$

Self-Inductance $= L = ?$

As we know that:

$$V = -L\frac{\Delta I}{\Delta t}$$

$$\Rightarrow -\frac{V\Delta t}{\Delta I} = L$$

$\Rightarrow$ putting given values:

$$\frac{\overset{40}{(200)}(0.1)}{8} = L$$

$\Rightarrow \quad L = 4$ Henry.

Part : a

AC Generator :-

Def:

A device which converts mechanical energy into electrical energy (AC) is called AC generator.

working principle:

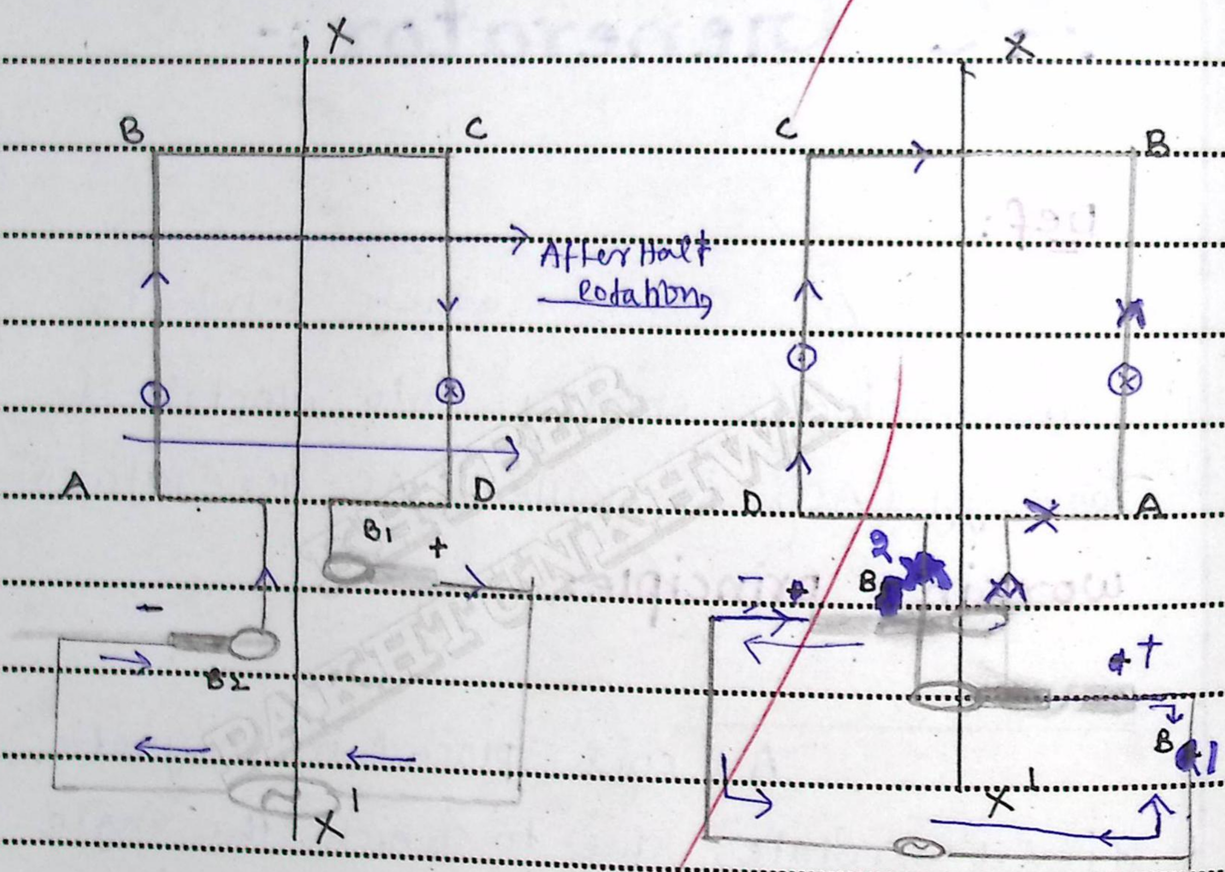
A coil placed in magnetic field rotates due to which the angle between the $\hat{n}$ and $\vec{B}$ changes. As a result, flux changes and Emf is induced.

Construction:

• AC Generator consists of a coil wound around an iron core. The iron core and coil is collectively called an Armature.

Armature has two terminals (wires) to which slip rings are attached usually made of Brass.

There are current leads attached to the armature which provide current to the load. They are usually made of graphite.



- The coil is capable of rotation at an axis at right angle to field.

Working:

Let us consider, the coil rotates clockwise. Then the side "AB" will move outside (●) and "CD" will move inside. By Right hand rule the direction of current in coil is "ABCD" and move in specific direction in load from right to left. (B_1+ and B_1-).
After half rotation, the coil will change its poles. Then the sides "CD" will move outside and the side "AB" will move inside. By Right hand Rule, the direction of current in coil is along "CDAB" that reversed its direction. Now current leaves the coil through B_2 and enters through B_1 (B_1- and B_2+).
The ~~coil~~ current has reversed its direction and flow from left to right in load.
Thus; in this way mechanical energy is converted into electrical energy. As the current changes its direction. Therefore, it is alternating current.

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CONTINUATION SHEET

Fic. No. 984

(صرف بورڈ کے استعمال کیلئے) امیدوار یہاں کچھ نہ لکھیں

QNO: 5

Part (a)

As we know that 1kg of any element contains avagadro number of atoms:

Mass of 6.023×10^{23} atoms of ^{12}C = 12kg

$\Rightarrow$ Mass of 1 ^{12}C atom = $\frac{12}{6.023 \times 10^{26}}$ kg

and mass of $\frac{1}{12}$ atoms of ^{12}C = $\frac{1}{12} \times \frac{12}{6.023 \times 10^{26}}$ kg

Therefore:-

$1u = 1.660 \times 10^{-27}$ kg.

b):-

As By Einstein mass-energy equivalence:

$\Delta E_0 = \Delta mc^2 = (1.660 \times 10^{-27} kg)(3 \times 10^8) m/s$

therefore;

$1u = 1.49 \times 10^{-10} J$

As we know that:

$$1u = (1.49 \times 10^{-10}\,J)\left(\frac{1eV}{1.6022 \times 10^{-19}\,J}\right) = 9.315 \times 10^{8}\,eV$$

Therefore:

$$\boxed{1u = 931.5\,MeV}$$

Hence proved.

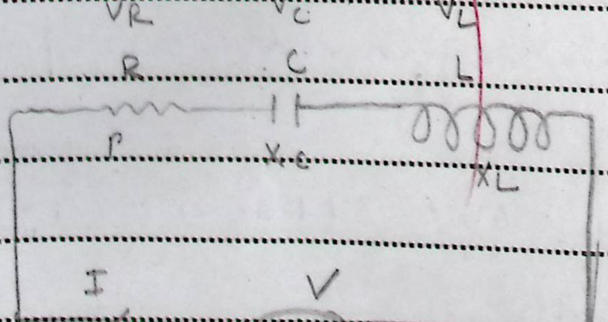
QNO: 5

R.L.C Series AC Circuit:

- An inductor, resistor and capacitor connected in series to AC source is called RLC series AC circuit.

Explanation:

Let us consider an inductor, resistor, and capacitor

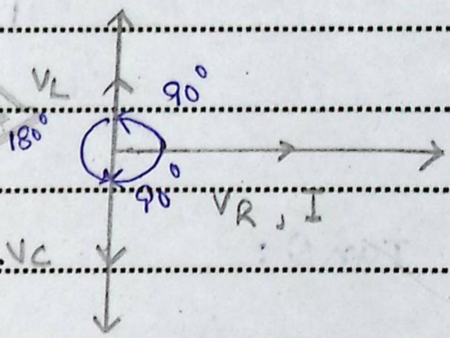


connected to AC source. As the current is same because they are connected in series. Let "I" be the current flowing through them. As potential difference is different across them: so; let V_R, V_L and V_C be the potential difference across resistor, inductor and capacitor.

Then;

- V_R and I are present in same phase.
- V_L leads I by 90°
- V_C lags I by 90°

The p. angle b/w the V_L and V_C is 180°

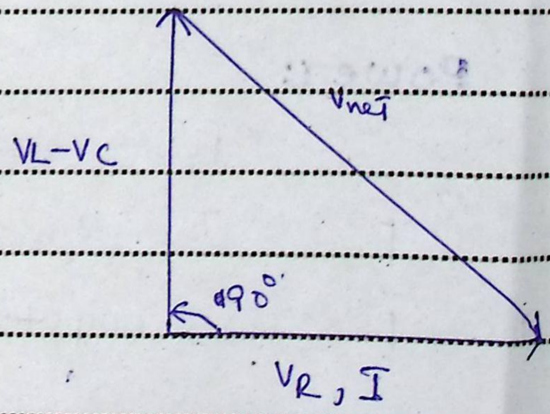


Therefore;

$$V_{LC} = \sqrt{V_L^2 + V_R^2 + 2V_L V_C \cos 180^\circ}$$

$$\Rightarrow \boxed{V_{LC} = V_L - V_C}$$

Let $X_L > X_C$ then the circuit is inductive.



:- **By Pythagoras Theorem:**

$$V_{net} = \sqrt{V_R^2 + (V_L - V_C)^2} \longrightarrow (1)$$

The :

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

current flowing in the circuit is:

$$I = \frac{V}{Z} = \frac{\sqrt{V_R^2 + (V_L - V_C)^2}}{\sqrt{R^2 + (X_L - X_C)^2}}$$

cosθ :

By Pythagoras theorem:

$$\cos\theta = \frac{\text{Base}}{\text{hyp}}$$

$$\cos\theta = \frac{V_R}{V_L - V_C}$$

Tanθ :

As;

$$\tan\theta = \frac{\text{Perp}}{\text{Base}} = \frac{V_L - V_C}{V_R} \Rightarrow \theta = \tan^{-1}\frac{V_L - V_C}{V_R}.$$

Power:

Power discipated by any circuit:

$$P = I_{rms} V_{rms} \cos\theta$$

The power discipated is in b/w 0 and 1.

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CONTINUATION SHEET

Fic. No. 984

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Question : 4

Part : b

Solution:-

As we know that:

$$\lambda = \frac{h}{p} = \frac{h}{mV}$$

$$\Rightarrow \lambda = \frac{h}{m\left(\frac{2\pi ke^2}{nh}\right)}$$

$$\Rightarrow \lambda = \frac{nh^2}{2\pi mke^2}$$

Putting values

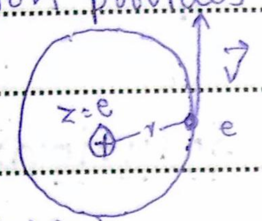
$$\lambda = \frac{(4)(6.6262)^2}{2(3.14)(9.11\times10^{-31})(1.6\times10^{-19})^2} = 0.133\times10^{-8}\,m.$$

$$\Rightarrow \lambda = 1.33\,nm.$$

Q No: 4

Bohr's postulate:-

1): Electron revolves around the nucleus in fixed circular paths called energy levels. The columbic force of attraction provides centripetal force to electron.



$$F_c = F_{col} \Rightarrow \frac{mv^2}{r} = \frac{K(e)(e)}{r^2}$$

$$\Rightarrow \frac{mv^2}{r} = \frac{Ke^2}{r^2}$$

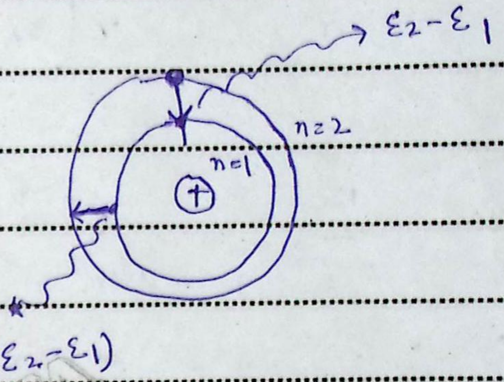
2): Electron only revolves in those energy levels for which angular momentum is quantized i.e the angular momentum is equal to the integral multiple of $\frac{h}{2\pi}$

$$mvr = \frac{nh}{2\pi} \quad \text{where } n = 1, 2, 3, 4 \ldots$$

3): As long as, electron reside in one energy level, it neither radiates nor absorb energy.

4) :- When an electron jumps from low energy level to high energy level it absorbs energy. However, when electron jumps from high energy level to low energy level it emitts energy. The energy emitted or absorbed is equal to the energy difference between energy levels.

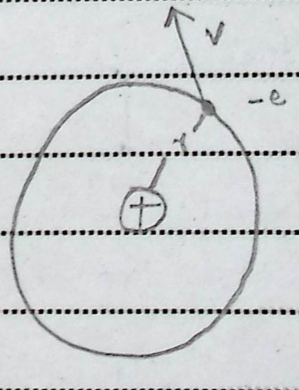
$$\varepsilon_2 - \varepsilon_1 = \Delta \varepsilon = hf.$$



:- Derivation for Radius:

:- Consider an electron revolving around the nucleus at distance "r" from nucleus.

According to Bohr's postulate: (2)



$$mvr = \frac{nh}{2\pi} \rightarrow (1)$$

$$\Rightarrow v = \frac{nh}{2\pi mr} \rightarrow (2)$$

Hydrogen Atom

Also from 1st postulate:-

$$\frac{Ke^2}{r^2} = \frac{mv^2}{r} \rightarrow (2)$$

putting the value of "v" in eq (2) ; we get:

$$\frac{Ke^2}{r^2} = \frac{m}{r}\left(\frac{nh}{2\pi mr}\right)^2$$

$$\Rightarrow \frac{Ke^2}{\cancel{r^2}} = \frac{\cancel{m}n^2h^2}{r4\pi^2 m^{\cancel{2}} \cancel{r^2}}$$

$$\Rightarrow (r) = \frac{n^2h^2}{4\pi^2 mKe^2}$$

As;

$$\frac{h^2}{4\pi^2 mKe^2} = 0.53A^0$$

therefore;

$$\boxed{r = 0.53 \times n^2} \rightarrow (A)$$

For $n=1$;

$$r = (0.53) \times (1)^2$$

$$\Rightarrow r_1 = 0.53A^0$$

For $n=2$ $\quad r_2 = (0.53) \times (2)^2$

$$= 0.53 \times 4$$

$$\Rightarrow r_2 = 2.116A^0$$

Hence eq (A) represents the equation for radii of atom.